Investigating the sustainability of medicinal plants and the loss of traditional knowledge in a rural community in Namaqualand.

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ABSTRACT

Up until the early 1990s conservation practices in South Africa were culturally biased, focusing largely on the value systems of the affluent. However, with the release in 1997 of the White Paper on the Conservation and Sustainable Use of South Africa's Biological diversity, the role that biological resources play in providing for the needs of all South Africans, is now emphasized. According to this policy, human needs must be considered if conservation is to be successfully implemented. Using this document as the framework for this study I chose to investigate various aspects of medicinal plant use in a rural community in Paulshoek, Namaqualand. The main aims were as follows: to evaluate the local knowledge regarding medicinal plants; to document the plants used and collected in Paulshoek; and to determine potential threats to the biological resource. This was achieved by employing a variety of social and ecological methods. It became apparent from the interactions and interviews with the residents that medicinal plants are an important resource to the Paulshoek community since more than 70% of the population regularly use herbal remedies. While there is some evidence to suggest that the local knowledge of medicinal plants is dying out, I would speculate that most of the knowledge has already been lost. Of the 15 plants used and collected in Paulshoek, most appear to be highly sustainable in the landscape. This conclusion was based on people's perceptions regarding the change in abundance of each of these species over time and by further comparing plant size between Paulhoek and adjacent commercial farms. As most medicinal species seem unaffected by either harvesting or land use practices this indicates that it is possible to achieve a sustainable harvest. Certain species do, however, show evidence of decline. Fuelwood harvesting most probably accounts for the change in abundance of *Rhus burchelli* over time, while *Mentha longifolia* may be facing some reduction in plant fitness due to harvesting for medicinal purposes. *Sceletium emarcidum* is on the verge of local extinction due to a combination of intensive harvesting and high grazing pressures. In contrast, high stocking densities appear to account for the increased abundance in both *Galenia africana* and *Ballota africana*. These findings clearly show that while the resource as a whole may be fairly resilient to harvesting and land use practices, certain species are in need of urgent conservation. This study further highlights the need to look beyond the direct impacts of harvesting and consider all possible threats, if the resource is to be sustainably managed. While this case study is atypical of the state of the medicinal plant resource in most of South Africa, this survey serves as a novel protocol for evaluating the sustainability of any resource which is regularly utilized.

CONTENTS

INTRODUCTION

The White Paper on the Conservation and Sustainable Use of South Africa's Biological Diversity (1997) focuses largely on the conservation of South Africa's biodiversity in the light of sustainable utilization which benefits all South Africans particularly the poor. According to the policy, 'sustainable use' is defined as "the utilization of a resource used at a rate within its capacity for renewal, or any practice that maintains the integrity of the natural systems that produce particular resources".

One of the main aims of this policy is to develop a framework for sustainable harvesting rates and utilization levels for species and ecosystems used for commercial, recreational or subsistence purposes. The document emphasizes that these harvesting arrangements must be based on "the long term sustainability" of the ecosystem or concerned species. The Paper thus recognizes the pressure that can be placed on ecosystems by human activities and aims to address conservation from a new perspective. In the past conservation practices have been culturally biased, focusing largely on the value systems of the affluent. A large thrust of the policy is to develop public awareness programmes, wherein local knowledge and understanding of biodiversity will be taken into account and where specific community groups will be encouraged to become more directly involved in conservation issues.

Finally the paper recognizes the unique and irreplaceable value of traditional knowledge, practices and cultures, and is particularly concerned about the rapid loss of such systems. The recording of knowledge and practices concerning the conservation and sustainable use of biodiversity is thus encouraged. In addition where possible, these systems will be protected, promoted, maintained and utilized.

This document clearly stresses the need for interdisciplinary studies regarding the conservation of South Africa's biological resources, emphasising the importance of acknowledging human needs if conservation is to be successfully achieved. The first purpose of this project was therefore to attempt to implement some of the recommendations previously highlighted within the framework of a project conducted on a communal range in Namaqualand. Since this topic is so large, I chose to focus my attention on the use and sustainable utilisation of medicinal plants in Paulshoek, a district in the Leliefontein Communal Reserve (Figure 1). In particular, I wished to assess the state of traditional knowledge in the area for three main reasons. Firstly, I wanted to establish the relative importance of the medicinal plant resource to the Paulshoek community. I further wanted to determine the rate at which knowledge may be disappearing and in so doing evaluate the need for further research and documentation of this vanishing "resource". And finally, I wished to assess the degree to which local knowledge and practises demonstrate a good understanding of the mechanisms required for conservation of their medicinal plant resource.

The second main purpose of this project was to assess the present state of the medicinal plant resource in Paulshoek and in so doing, attempt to evaluate any threats to its long-term sustainability. By assessing the relative impact of various harvesting and land-use practises on the resource, I hoped to be able to determine the extent to which harvesting for medicinal purposes is ecologically sustainable. This was done in order to challenge the basic tenet of the White Paper which presumes that resources can in fact be sustainably utilized. Empirical studies affirming or refuting this assumption are imperative if the Policy is to be successfully implemented.

These aims were achieved by developing and using a combination of social and ecological methodologies to answer the following questions:

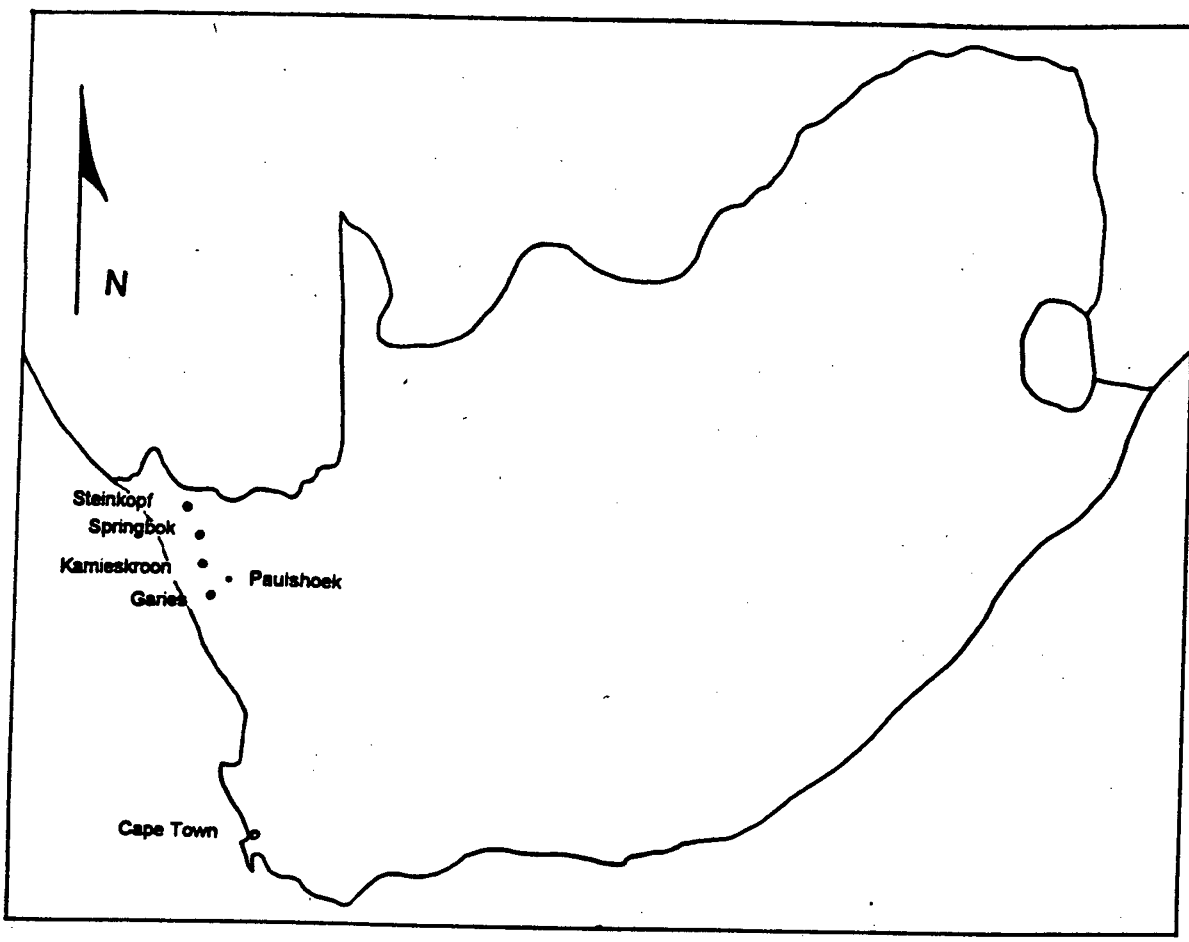

Figure 1: Map showing the position of Paulshoek in South Africa.

1. **What is the state of medicinal-plant knowledge in the community of Paulshoek?** Is the knowledge held by only a few individuals or is it knowledge that is widespread in the community? By answering these questions, the "sustainability" of knowledge can be assessed, and some idea can be obtained of how urgently the knowledge needs to be documented.

2. **How important are medicinal plants to the Paulshoek community?** What plants do people use and how regularly are they used? By evaluating the extent to which the community relies on medicinal plants, the "value" of this resource to Paulshoek residents can be assessed. This should give some idea of how willing the community would be to become involved in conserving the resource assuming it is threatened. Addressing these questions further allows for documentation of the medicinal resource base in Paulshoek.

3. **What is the conservation status of the resource?** To answer this question, the direct impact of harvesting for medicinal purposes was considered as well as other practises which might negatively influence the state of the resource. The relative impacts of fuelwood harvesting were kept in mind when assessing potential impacts, as well as land use practises. Communal areas in Namaqualand are generally heavily grazed, and the potential impacts of livestock were therefore given particular attention in this regard.

By addressing these questions I hoped to be able to assess not only the state of knowledge and whether it is possible to use a plant resource sustainably, but also to assess the factors that need consideration for successful conservation of a resource as a whole.

STUDY AREA

The study was conducted in the Paulshoek district and on two adjacent commercial farms. Paulshoek (30°24'S; 18°08'E) is an area within the Leliefontein communal reserve, situated at the southern end the Kamiesberg, a mountainous region, with elevations ranging between 900 and 1250 m above sea level. The area is characterised by large granite domes and hills, separated by sandy plains.

It is a semi-arid region, receiving an average of between 150 and 250 mm rain annually most of which falls in the winter months. Rainfall can be highly sporadic and drought events are fairly common. Summers are usually hot and dry with average daytime temperatures of about 22°C in January. Winter temperatures are fairly cold to mild during the day (10-12°C in July) but nights are often characterised by frost events.

The vegetation of the area is broadly described as Namaqualand Broken Veld (Acocks 1988). The plains are characterised by asteraceous shrubs and mesembs, while the steeper slopes are dominated by a higher proportion of woody shrubs. Trees and perennial grasses are relatively uncommon, both generally restricted to the watercourses of the semi-perennial rivers.

Quite a marked difference is observed between vegetation in Paulshoek and commercial areas, especially on the sandy plains. While shrubs such as *Pentzia incana*, *Eriocephalus africanus* and *Chrysocoma* spp, and leaf succulents such as *Ruschia robusta* and *Leipoldtia* spp are fairly common in both areas, only the Paulshoek landscape is dominated by *Galenia africana*. This species is a highly unpalatable shrub (Todd and Hoffman 1998) known to cause fatalities in livestock if too much is consumed (Vetter 1996). It is usually characteristic of highly disturbed or heavily grazed veld.

THE PAULSHOEK COMMUNITY

Most of people living in the Leliefontein Communal Reserve are descendants of the Nama- speaking Khoi, who were pastoralists that had inhabited the fertile regions of Namaqualand as early as 1500 years ago (Webley 1982). Being closely related to the San who are thought to have occupied Southern Africa for the last 200 000years (Cunningham and Davis, 1997), the Khoi undoubtedly had a vast understanding and knowledge of the local vegetation and its variety of uses.

Prior to the 1700s the Khoi were thought to have occupied a large area covering 47 000 km^2, with the Kamiesberg traditionally being home to a large Nama group. However, contact with European settlers soon broke down their nomadic way of life and by the mid-1800s those who had not left the area to join the Great Namaqua north of the Orange River, had mostly settled at a mission station, called "Leliefontein" in the Kamiesberg. Leliefontein Communal Reserve was established as an official "coloured" reserve in 1854. Today most of the residents in the reserve have lost their traditional Nama language and almost only speak Afrikaans. Further, many of the traditional practi~~s~~ces have been forgotten (Archer 199?), and have given way to strong western ideologies.

Despite this apparent loss of traditional knowledge, preliminary investigations by May *et al (*1997) indicate that indigenous plants are still widely used by many households for a variety of purposes. Since the village of Paulshoek has no access to electricity, most of the households rely heavily on fuelwood as an energy source (May et al 1997). Furthermore, with the village being almost 40km away from the nearest doctor, ongoing use of plants for medicinal purposes has been necessitated until fairly recently. For the last few years, however, a mobile clinic has visited the region once every two weeks.

Traditional healing is still practised in the region, and three official herbalists or "bossiedoktors" are recognised in the district of Paulshoek. The knowledge of these specific healing systems seems to be passed down through the family, with the present "bossiesdoktors" being at least third-generation practitioners (May *et al* 1997).

Most of the ca. 800 people living in the district stay in Paulshoek village itself, which consists of about 140 households. It consists largely of pensioners, with the majority of the younger people living elsewhere in Namaqualand in order to earn a living. Most households are relatively poor, with a large part of the community depending on disability grants or welfare as their main source of income (May *et al* 1997). Agriculture also contributes significantly in this regard, mainly in the form of livestock farming. Paulshoek has 37 official stock farmers (May *et al*, 1997), who farm mainly goats and sheep. While exact stock numbers for the area have not yet been determined, the mean stocking rate of livestock over the last 30 years has been estimated to be 6Ha per small stock unit, which is twice the rate recommended for the region by the South African Department of Agriculture (Todd and Hoffman 1998).

MATERIAL AND METHODS

In order to assimilate the relevant information on medicinal-plant knowledge and use in the Paulshoek district, I employed several sociological techniques over and above collecting ecological data in the field. Since each served a slightly different purpose and were used to answer a variety of questions, where appropriate I will refer to the technique employed rather than explaining the relevant method each time I refer to it. For the sake of clarity however a brief outline and motivation of each method follows.

- **Brief interviews** – A total of 26 households were randomly selected. A representative of each was asked several questions regarding the household's use of local medicinal plants. Other information obtained included the number of people living in the house, the number of children, and the number of people that collect medicinal plants. The information from these interviews was used to estimate what proportion of the Paulshoek population uses medicinal plants. The questions asked during this interview are presented in Appendix 1.

- **Detailed interviews** – 17 interviews were conducted with residents who either use and/or collect plants for medicinal purposes. These interviews attempted to represent all sectors within the community namely villagers (people who live and/or work predominantly in Paulshoek), stock-farmers (people who spend the majority of time at their stock posts) and herbalists. Both male and female villagers were interviewed. Information obtained from the respondents included the medicinal plants used and collected in the Paulshoek district, the parts of the plants that are harvested and perceptions of how the abundance of plants have changed over time. Information on traditional lore of medicinal plants was further obtained, and their opinions on the decline of local knowledge were further recorded. A sample of the interview questions is presented in Appendix 2.

- **PRA** (Participatory Rural Appraisal): This is a very powerful sociological method which has gained great popularity in recent years. Participants are usually placed in groups of three people or more, and are asked to workshop a particular problem or question as a group. The final solution or answer is taken as the consensus opinion of the entire group. Discrepancies between groups are subsequently addressed and clarified. Thus, while statistical analyses can not usually be performed on the information obtained (the sample size is usually very small), it gives a very clear indication of the overall perceptions of a group or community and also highlights areas of contention.

  My main motivation for using this method was to obtain consensus opinions of the Paulshoek community, regarding various aspects of the medicinal-plant resource of the area. A total of 10 participants were placed into 2 groups and were asked the questions listed in Appendix 3.

For the remainder of the text, the relevant sociological method will be referred to by the terms, above, highlighted in bold.

1 The state of local knowledge

To assess the state of local knowledge regarding medicinal plants, I initially determined how widespread the knowledge is by asking respondents in the brief interviews how many people in their households use or collect indigenous plants for medicinal purposes. Using additional information obtained from these interviews regarding the total number of people living in the households, I was able to estimate the proportion of the village that has some knowledge of medicinal plants. I thus hoped to use this information as a preliminary evaluation of the potential vulnerability of the "knowledge base", assuming that if the knowledge appears to be restricted to a few individuals, it is more likely to be lost than if it is widespread within the community. Obtaining an estimate of the average

age of the people who use or collect medicinal plants, further helped me to assess whether knowledge is being passed down to the younger generations, since this is an important factor to consider when assessing the potential decline of the knowledge base.

I further wished to determine whether there are particular sectors or individuals within the community who are perceived to possess "superior" knowledge to the rest of the community. I achieved this by asking the respondents from the brief interviews who they thought were the most knowledgeable about medicinal plants. In addition I conducted numerous detailed interviews with people who collect medicinal plants in order to evaluate whether any divisions or differences in knowledge exist. This was achieved primarily by comparing the range of plants mentioned by the various respondents and assessing whether there were certain plants known or used by only a few individuals or a particular sector within the community.

2 Medicinal plant use in Paulshoek

2.1 Plant identification

In order to obtain a comprehensive list of medicinal plants collected in the Paulshoek district, interviews were conducted with 17 Paulshoek residents who either made use of plants for medicinal purposes, or who collected the plants themselves. Since only the common names for the plants were mentioned, I was taken into the field by one of the respondents, where the majority of the plants were found. Herbarium specimens were collected and later identified. Several other interviewees were asked to help point out the plants, which had not been identified on this occasion. Various references on common names of plants were also used to complete identification (Archer 1994, Smith 1966, le Roux and Schelpe 1988). To make absolutely certain that the correct plants had been identified, specimens of all the commonly used plants were collected and brought to the PRA, where participants were asked to identify them. In all cases, correct identification was made.

It should also be noted that one of the plants used medicinally, is *Galenia africana* a highly unpalatable plant that is found in great abundance in heavily grazed areas. Since it is assumed that harvesting would have no impact on the resource, combined with the fact that it is generally viewed as an "undesirable" plant, this species was excluded from further analysis.

3 The conservation status of the resource

The main aim of this part of the study was to evaluate the ecological state of the medicinal plants in Paulshoek as a whole, and further to attempt to identify possible threats to the long-term sustainability of this resource. The White Paper focuses only on the potential impacts of direct harvesting on sustainability of biological resources, which I feel is somewhat inadequate in light of the numerous other pressures and threats that biological resources frequently face. Understanding all threats to a resource is imperative for effective conservation management, and by focusing only on the direct impacts of harvesting, more important or serious threats to the long-term sustainability of the resource can be overlooked. I would thus rather shift the emphasis to assess whether the resource appears threatened given all possible pressures.

Within the context of Paulshoek I have identified three main factors which could potentially have negative impacts on the medicinal plant resource. These are: harvesting for medicinal purposes, harvesting for fuelwood, and various pressures resulting from land use practises, especially the high stocking density of goats and sheep in Paulshoek. Livestock can have negative impacts by direct browsing or grazing but may also indirectly affect the plant resource through ecosystem transformation. For example, facilitation by nurse-plants is important for the seedling establishment of several species in arid lands, and heavy grazing and browsing usually reduces vegetation cover, which effectively reduces suitable sites for seedling establishment.

The potential impact of harvesting for medicinal purposes was however rigorously investigated, since one of the aims of this project was to determine whether it is possible to *use* a resource sustainably. Thus several of the methods which are outlined below were specifically aimed at evaluating the degree to which the present state of the resource could be attributed to harvesting pressure. Impacts of livestock were also carefully examined.

3.1 Potential impact of harvesting

Before observed ecological patterns of the medicinal plants could be attributed to direct harvesting, the potential impact of collecting needed to be evaluated. This was done by assessing the vulnerability of each species to harvesting in terms of growth-form, the parts harvested and the amount collected in relation to their relative abundance in the landscape.

3.1.1 Growth form

All medicinal plants identified were assigned to a category based on growth form and life history. These are as follows: large woody shrub, greater than 1m in height; small woody shrub, smaller than 1m in height; annual herb, perennial herb, succulent, geophyte. The categories are in a subjective, approximate order of increasing vulnerability to harvesting, with geophytes undoubtedly being the most susceptible to local extinction due to harvesting pressure. This is because the entire plant is invariably harvested for its bulb. Annual herbs and succulents also tend to be vulnerable to harvesting for similar reasons. In contrast, larger woody plants in Namaqualand and the Richtersveld are more often harvested for their leaves, and when bark is removed, the individual is usually not ring-barked (Archer, 1994; Cunningham and Davis, 1997). Thus even fairly intensive harvesting usually does not have a detrimental effect on an individual. This is providing that individuals are not harvested whole before they have an opportunity to set seed, and also providing that the fruit or seed is not intensively harvested.

3.1.2 Plant parts harvested

Each species was assigned a category based on the parts of the plant that are picked. These are as follows; in increasing order of relative impact of harvesting: leaves or branches, apical buds, stems, reproductive organs, underground organs, entire plant.

3.1.3 Relative abundance

The relative abundance of each of the species was subjectively assessed in the field and divided into the following categories: Very abundant (VA), where the plant is found throughout the landscape, in most habitat types; Fairly abundant (FA), where the plant is abundant, but usually demonstrating some habitat restrictions; or Rare (R), where the plant is either abundant but very restricted in habitat, or extremely scarce in the landscape

3.1.4 Amount harvested

To quantify how heavily each species is utilised for medicinal purposes, I had to estimate how many people use a particular plant, how much they use for one dose and how often they use it. Combining these factors would give at least a relative estimate of the amount harvested by the community each year.

Estimation of the number of people that use a particular plant was obtained in the following way:

All respondents of the detailed interviews were asked how many people live in their households. This gave an estimate of the total number of people represented by these respondents. It was assumed that any plants used or collected by these interviewees would be used by the entire household. Thus, by noting which respondents mentioned a particular plant, I was able to calculate the proportion of people represented in these detailed interviews that make use of a particular plant. Since I assumed that this population sample reflected overall patterns of use by the entire community, I was able to approximate the number of Paulshoek villagers who use each medicinal plant as follows:

$$P_E = N_E / N_A * P_A$$

Where N_E is the number of people represented in the detailed interviews that use a particular species, N_A is the total number of people represented in the detailed interviews and P_A was the total number of Paulshoek residents that use medicinal plants (see 2.1 for details).

In an attempt to quantify the amount of each plant annually harvested by the Paulshoek community, participants in the PRA were asked to demonstrate the amount of each plant required for a dose for one person. Since most of the plants are used for common ailments such as fever and influenza, it was estimated that each person would make use of each plant an average of twice a year. Using this information, the amount of each species (measured either as number of stems, number of flower heads, number of branches or number of individuals) annually utilised by the community, was calculated as follows:

$Amount = 2 * A_E * P_E$

Where A_E is the amount of a particular species used for one dose and P_E is the estimated population within the community that makes use of the plant in question. In the case where stems were the unit of measurement, the conversion to number of plants harvested, was determined by using the average number of stems possessed by a particular plant (for methods of data collection, see section 3.1). Where apical buds are used, the average number carried by the plant was visually estimated in the field, thereby allowing for an assessment of the number of plants annually affected by harvesting. Where the amount was measured in terms of branches, this was converted to number of individual plants by roughly estimating the average number of branches of relevant size found on the plant in question. It must be stressed that this latter estimation is only semi-quantitative in that it gives a relative idea of how heavily the particular species is harvested. Further, three species (*Pentzia grandiflora*, *Sceletium emarcidum* and *Sutherlandia frutescens*) were not available at the time, and therefore only verbal estimates were obtained of amounts used for a single dose.

3.2 Ecological state of the resource

To assess whether the medicinal plant resource is in fact threatened or facing decline, both social and ecological methods were employed. The participants of the PRA were asked to evaluate how the relative abundance of each species had changed over time. This allowed for immediate identification of the plants facing population decline.

Various morphological attributes of the species were also assessed. This was done for a number of reasons. Firstly reduction in abundance is not the only measure that reflects reduced fitness of plant populations. Some species may be able to persist in the landscape for a long time under adverse conditions but their size or reproductive capacity may be significantly reduced. It is thus important to recognise the symptoms of threatened populations. Secondly, by comparing meaningful morphological traits between populations where potential threats are recognised and can be quantified, the relative impact of each of these pressures can be evaluated.

I chose to evaluate the relative impact of the three potential threats already identified on each medicinal plant species by comparing average size and stem number (where appropriate) of individuals found in the communal areas, with those found on the commercial farms. Paulshoek residents are not permitted to harvest plants from the commercial areas for any reason. In addition, it is known that stocking densities are substantially higher on communal land. Thus commercial sites can be used as semi-controls in determining whether the three potential pressures in combination have a significant impact on the fitness of the various plant species.

In an attempt to establish whether these factors had any impact in the sustainability of the medicinal plants, the number of stems, height and diameter of at least 30 individuals of each species was recorded in both the commercial and communal areas. They were sampled at a variety of sites to reduce site-specific effects which might bias results. The relative size of each plant was determined by calculating its volume using the equation employed by Phillips and MacMahon (1981), where the plant is assumed to be an oblate spheroid. Statistical comparisons were subsequently made, using a Mann-Whitney U test (Zar, 1984), to determine whether plant volume of each species differed significantly between the commercial and communal areas. Average stem number was similarly compared for woody plants and for perennial herbs that demonstrate clonal growth. Where statistical analysis yielded no significant differences in either of these traits, it was assumed that these species were relatively unaffected by both harvesting and land use practises, and therefore not facing any immediate threats. This was providing that the species had not demonstrated a decline in abundance over time (as noted by the participants of the PRA). Where significant differences were observed it could be concluded that one or more of the factors identified was having a substantial effect on the state of that species.

The relative impacts of each factor were then separately evaluated for each species. This was done by firstly identifying the plants which are harvested for their wood and by determining the degree of palatability of each species, using information obtained from several stock farmers and the PRA participants, as well as from several literary sources (le Roux and Schelpe 1988; Shearing 1994). Using this information in combination with the findings regarding the potential impact of harvesting for medicinal purposes, the factor(s) most likely to account for the observed patterns, could be assessed.

Having established the overall state of the resource as well as the relative vulnerability of component species, four species were chosen for closer investigation. In particular the relative impact of livestock of these plants was determined. I felt that a more in depth assessment of this factor was warranted, based on the fact that livestock can substantially transform ecosystems and severely affect the fitness of plants.

The four species ~~were~~ chosen for closer examination were: *Salvia dentata, Ballota africana* (L.) Benth, *Mentha longifolia* (L.) L. and *Sceletium emarcidum* (Thunb.) L. Bolus. *S.dentata* is a fairly large woody shrub, thereby representing the category of plant least likely to be significantly affected by either livestock or harvesting. The remaining three plants are all harvested fairly intensively as well as being fairly rare in the landscape. *B.africana* and *M. longifolia* are both fairly unpalatable perennial herbs capable of vegetative propagation, but the latter is only found along river courses. *S. emarcidum* is a low growing highly palatable succulent, often found beneath other plants. Plants belonging to this genus have been highly esteemed and sought after, and have a long history of medicinal use (Smith *et al* 1995).

Populations of each species were located and habitat preferences visually assessed. Sites were then selected in both commercial areas and in Paulshoek itself. A site was chosen depending on the presence of the species in the general area. This was done in order to reduce the possibility of choosing a site whose habitat does not naturally support the species. Three transects were then randomly chosen within this area, to reduce the bias of this method of site selection. In the case of *M.longifolia*, the banks of the river were viewed as separate transects, and thus only two transects were investigated at each site. Three sites were chosen for each species. Six transects, each 50m in length, were investigated in both communal and commercial areas for this species, compared to nine transects (25m X 10m) for the remaining three species.

Overall abundance of the relevant species was obtained by counting the number of individuals found within each transect. Average abundances in commercial versus communal areas, were then compared, using a Mann-Whitney U test. Lack of significance was taken to indicate that the species in question is not influenced by either land tenure or harvesting practices of any kind, and should be reflected in the residents' perceptions regarding the change in species abundance over time.. Where significant differences were observed, the relative impact of livestock, in contrast to direct utilisation, was investigated.

While it is commonly assumed that stocking densities differ substantially between the communal areas and adjacent commercial farms, I wanted to test this assumption statistically to ensure that the impacts of livestock are significantly different. I used the method employed by Vetter (1996) to achieve this. According to her protocol dung is used as an indicator of habitat use and stocking density. 27 and 24 transects of 25m by 10m were walked in the communal and commercial areas respectively covering a range of comparable habitats. Each transect was divided up into ten 5m by 5m units. The presence and age of the dung (belonging to goats, sheep or donkeys) was used as a surrogate for assessing the frequency of animal occurrence at each site. Scores were allocated to each quadrat as follows: quadrats without dung were given a score of zero, while the presence of old dry grey dung was given a score of 1; dung of intermediate age was given a score of 2 while fresh dung was awarded a score of 3. Scores for each of the 10 quadrats were then added up to give a total value between zero and 30. Donkey and goat and sheep dung were not differentiated. While this may result in some discrepancy in terms of grazing intensities and impacts of grazing (since feral donkeys are not found on commercial farms), general differences in stocking densities should still be observed. Average dung-counts for commercial and communal areas were then compared using a t-test for independent samples (Zar 1984) where a significant result was assumed to indicate a significant difference in stocking density.

Having established that dung-counts do indeed differ between the commercial farms and Paulshoek, significant differences in abundance between these areas could legitimately be attributed, at least partly to differences in browsing pressure. Where plant abundance differed significantly, the potential impact of livestock was further evaluated by correlating species abundance with dung counts for all sites combined.

Where livestock appeared to influence the abundance of the species under investigation, the dynamics underlying their potential impacts were further analysed. Where an inverse correlation between abundance and dung-counts was observed, it was assumed that grazing or browsing directly influence population size. This pattern should be confirmed by information on the plant's palatability. An alternative explanation for this pattern could lie in the fact that many plants in Paulshoek are thought to need nurse plants to facilitate establishment. Livestock may thus affect plant abundance indirectly by reducing plant cover and thus suitable sites for seedling recruitment. However where a positive relationship is evidenced herbivory may influence the plant indirectly by means of competitive release due to the reduction of other competitively superior but palatable plants.

Since possible explanations lie in the plant's interaction with the surrounding vegetation, total plant cover and composition in each transect was estimated by laying out a tape measure and noting what was observed beneath. This was done along the entire length of each transect. Where plants could not be identified to species level, either the generic name or some descriptive name was used.

Of the four species investigated, only *Ballota* and *Sceletium* were significantly affected by grazing. Since both were found predominantly under the canopy of other plants, only the nursing effect was investigated in greater detail.

In the case of *B.africana*, a chi-square test was used to assess whether it occurs more often in the open or under the cover of other plants. The expected distribution if no habitat selection was occurring was calculated from the proportion of bare ground in each site. This was compared to observed frequencies of *Ballota* found in each habitat. The frequency distribution was calculated separately for commercial and communal areas, in order to assess whether the patterns observed, were consistent.

Preferences for particular nurse species were also investigated. Since only two individuals were observed growing under plants less than 1m high at all sites, plants smaller than this height were presumed to be unsuitable nurses and were therefore excluded from further analysis. The average cover of the remaining species was calculated for the commercial and communal areas separately, and expected abundance of *Ballota* was determined in the same way as above. The relative contribution of each species to the total χ^2 value was assessed and figures that exceeded a critical chi-square value of $p < 0.05$ were assumed to indicate a significant deviation from the expected. Partitioning χ^2 in this way serves to indicate which species deviate most from expected, and in this analysis allowed for the assessment of the plants most likely to be suitable nurses.

Similar analyses were carried out on *Sceletium*, except that, since it was never found in the open, only its nurse preference was investigated. Further, due to its scarcity in Paulshoek, frequency distribution patterns could only be assessed for the commercial areas.

RESULTS:

1 The state of local knowledge

Of the 82 people represented in the brief interviews, just over 70% made regular use of medicinal plants, and about 36% collected medicinal plants themselves. This converts to approximately 560 people within the community that possess some knowledge of this resource, and about 300 who potentially have a more in depth knowledge, assuming this sample is representative of the entire Paulshoek population. While it appears that a substantial proportion of the community has some knowledge of the medicinal plant resource, more than 80% of the people who collect medicinal plants are over the age of 50, with none being younger than 40.

22 of the 26 respondents from the brief interviews identified the official herbalists in Paulshoek as the most knowledgeable people in the village, although four interviewees stressed the point that it was the deceased "bossiesdoktors" who had known the most about medicinal plants in the region. 3 respondents implicated women as being particularly knowledgeable, while a further 3 respondents felt that everyone had equivalent knowledge in this regard.

From the more detailed interviews it was very apparent that a distinct division exists between the knowledge of most of the Paulshoek residents and the herbalists. While there was some overlap in the plants mentioned between these two groups, most of the species used by the herbalists is collected from fynbos fragment in the southern Kamiesberg. It was however clear that the "bossiesdoktors" knew the majority of plants mentioned by the other respondents, who, in contrast generally seemed to have knowledge of a limited number of medicinal plants. Another interesting trend is that a total of 22 different medicinal plants were mentioned by the 15 "non-herbalist" respondents, compared with 21 mentioned by the two herbalists. This indicates that the medicinal knowledge of the latter group is greater than that of the former, in that the two "bossiesdoktors" were easily able to name as many medicinal plants as were named by 15 "non-herbalists".

2 Medicinal plant use in Paulshoek

Table 1 displays a comprehensive list of all plants mentioned by the respondents, which are found and collected in the Paulshoek district. Plants that are collected outside the Paulshoek boundaries are not included in the list. Information on various attributes, obtained from respondents of the detailed interviews and participants of the PRA, is included in the table.

3 Conservation status of the resource

3.1 Potential impact of harvesting

The district of Paulshoek is endowed with three official "bossiesdokters" (herbalists), all of whom are stock-farmers. While about 50% of the Paulshoek residents have been treated by them at some stage, relatively few make use of them on a regular basis. From the brief interviews conducted, it became apparent that Paulshoek residents generally only make use of traditional healers as a last resort, or for unusual or uncommon ailments. Most of the respondents indicated that they visit conventional medical practitioners before considering the herbalists as an option. This is despite the fact that the nearest doctor is in Garies, about 40km away, and that a mobile clinic only visits once every two weeks. This general impression is confirmed by the two herbalists interviewed, who said that most of their patients do not live in the local vicinity.

Table 1: A list of medicinal plants, used and collected in the Paulshoek District. Species names accompanied by an asterisk, are those which are harvested for fuelwood. Two asterisks indicate preferred fuelwood. Degree of palatability is categorised in the following way: 0: Unpalatable; 1: Palatable but not sought after by livestock; 2: fairly palatable; 3: highly palatable. The capital letters in the penultimate column are abbreviations for the following parts picked: **A**: apical buds; **B**: branches; **L**: leaves; **S**: stems; **W**: whole plant.

Species	Common Name	Growth Form	Parts picked	Palatability
Ballota africana (L.) Benth.	Kattekruie	Perennial herb	S	0
Chrysocoma microphylla	Vuurhoutjie	Small shrub	W	1
Crassula muscosa L. var. *muscosa*	Akkedisstert	Succulent	W	0
Diospyros austro-africana De Winter var. *austro-africana**	Kraaibos	Large shrub/tree	L, B	0
Dodonaea viscosa Jacq. Var *angustifolia* Benth.**	Ysterhout; Xhoubie	Large shrub/tree	L, B	2
Galenia africana L. var. *africana*	Kraalbos	Small shrub	L, B	1
Mentha longifolia (L.) L.	Balerja; Kruistement	Perennial herb	S	1
Pentzia grandiflora (Thunb.) Hutch.	Stinkkruid	Annual herb	W	2
Pteronia incana (Burm.) D.C.	Krakrakie	Small shrub	L, B	1
Rhus burchellii Sonder ex Engl. **	Taaibos	Large shrub/tree	L, B	2
Salvia dentata Ait.	Salie	Large shrub/tree	L, B	1
Salvia sp.	Koorsbos	Perennial herb	S	2
Sceletium emarcidum (Thunb.) L. Bolus.	Kougoed	Succulent	W	3
Senecio cinerascens Ait.	Vieroulap	Perennial herb	A	1
Sutherlandia frutescens R. Br.	Jantjie-bêrend; Kankerbos	Small shrub	L, B	3

The herbalists receive between 10 and 20 patients a month, which is a relatively small number compared to the number of people treated by traditional healers in other communities in South Africa (Cunningham 1990). In addition, most of the plants used by the herbalists are collected from a Fynbos remnant outside the Paulshoek district. The only plants that are found in Paulshoek, which are occasionally used, are *Sutherlandia frutescens, Mentha longifolia* and *Sceletium emarcidum.* Thus the impact of herbalists on the Paulshoek medicinal resource *as* a whole appears to be minimal although Sutherlandia, *Mentha* and *Sceletium* may be affected to some degree by traditional herbal practises.

Although many Paulshoek residents use western medicine, it has already been noted that about 560 Paulshoek residents use medicinal plants. This may be a sufficient number to place considerable pressure on the resource. However, the medicinal-plant resource consists largely of growth forms that are fairly resilient to harvesting, with more than 50% of the species being either large or small shrubs (Figure 2). In addition, leaves and branches are the most commonly harvested parts of the plants (Figure 3), which are generally removed from the resilient growth forms (Table 1). Furthermore, four of the six species mentioned by more than half the respondents are large woody shrubs. This implies that the plants most commonly used tend to be those least vulnerable to local extinction due to harvesting.

There are a few plants which do however seem more vulnerable to harvesting pressure. There are several species used which have more vulnerable growth forms (Figure 2), such as *Sceletium emarcidum*, *Crassula muscosa*, *Mentha longifolia*, and *Scenecio cinerascens* (Table 1) and for these species the parts picked are stems, apical buds or the entire plant (Table 1, Figure 3) which can cause considerable damage to the plant populations. Furthermore, from Table 2, it is evident that these plants are both relatively rare in the landscape and are the plants most intensively harvested.

Table 2: Harvesting pressure of medicinal plants in relation to their relative abundance in the Paulshoek communal area. Abundance categories were assigned as follows: **VA**: very abundant, found in most habitat types; **FA**: fairly abundant, usually found in several habitats; **R:** rare, either found in specialised habitats or scarce in the landscape. Figures marked by an asterisk, are very crude estimates of numbers of individuals harvested.

Species	Abundance in the landscape	No plants harvested / year
Galenia africana	VA	-
Rhus burchellii	VA	*<2
Pteronia incana	VA	10
Chrysocoma microphylla	VA	100
Diospyros austro-africana	FA	*<2
Dodonaea viscosa	FA	*<2
Salvia dentata	FA	*<2
Pentzia grandiflora	FA	160
Sutherlandia frutescens	FA	290
Ballota africana	R	85
Sceletium emarcidum	R	*180
Senecio cinerascens	R	225
Salvia sp.	R	250
Crassula muscosa	R	320
Mentha longifolia	R	350

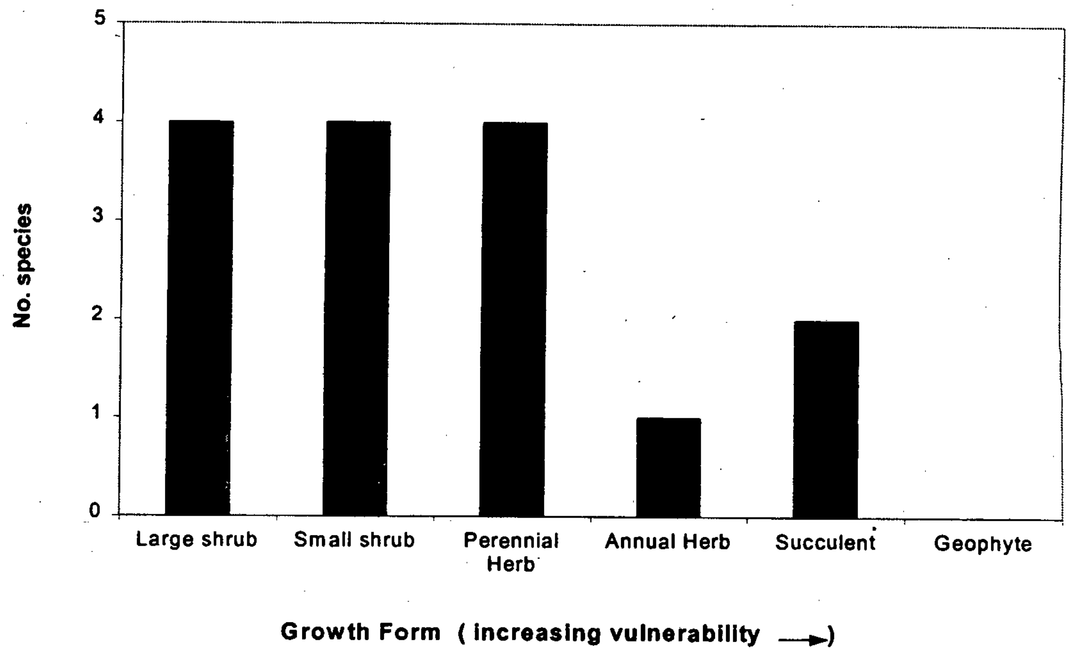

Figure 2: Relative vulnerability of the medicinal-plant resource in terms of growth form.

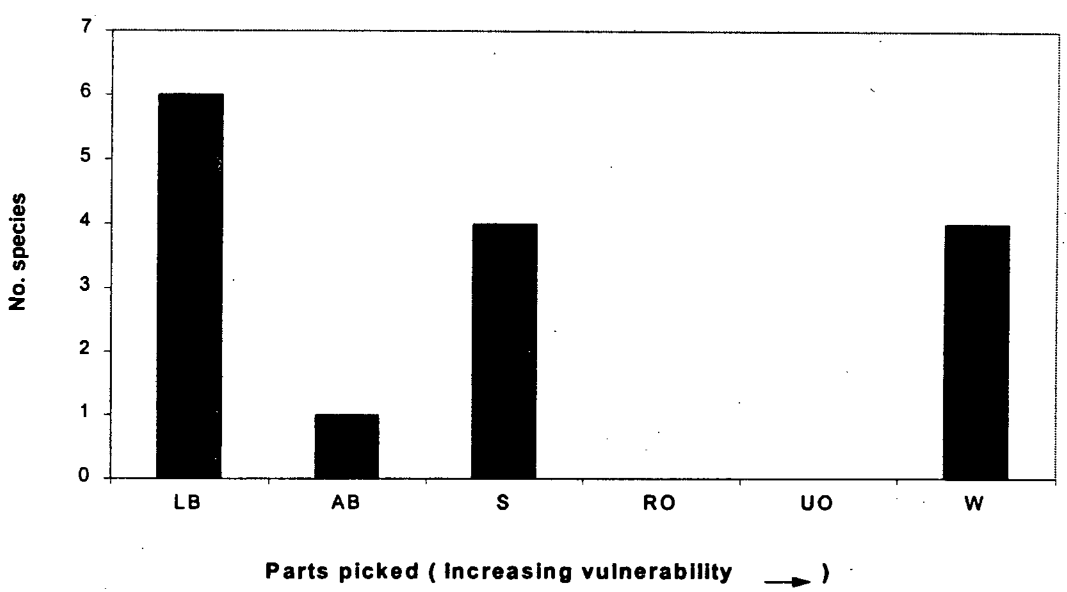

Figure 3: Relative vulnerability of the medicinal-plant resource in terms of parts picked. Abbreviations below each bar represent the following parts picked: **LB:** Leaves and branches; **S:** stems, **AB:** apical buds; **RO:** reproductive organs; **UO:** underground organs; **W:** Entire plant.

3.2 Ecological state of the resource

Table 3 displays the perceptions of the participants of the PRA regarding the change in abundance of medicinal plants in Paulshoek over time. It is clear that in general the abundance has remained unchanged over time, with only *Rhus burchelli* and *Sceletium emarcidum* demonstrating a marked decline. *Scenecio cinerascens*, *Salvia* sp. and *Mentha longifolia* have experienced some reduction in abundance. As expected, *Galenia africana* has shown a substantial increase in abundance over time which corresponds to high livestock pressures in the area.

Table 3: Changes in abundance of medicinal plants in Paulshoek. Values are assigned as follows: **0:** no observed change; **-1:** a slight decline in abundance; **-2:** a large decline in abundance; **+2:** a large increase in abundance.

Species	Change in abundance
Ballota africana	0
Chrysocoma microphylla	0
Crassula muscosa	0
Diospyros austro-africana	0
Dodonaea viscosa	0
Galenia africana	+2
Mentha longifolia	-1
Pentzia grandiflora	0
Rhus burchellii	-2
Salvia dentata	0
Salvia sp.	-1
Sceletium emarcidum	-2
Senecio cinerascens	-1
Sutherlandia frutescens	0

Of the 12 medicinal plants for which volumes were calculated, only *D.viscosa* and *C.muscosa* demonstrate a significant difference between commercial and communal areas (Table 4). Using a t-test the p-values were found to be 0.041 ($t=2.0843$; $df=58$) and 0.031 ($t=2.2074$; $df=58$) for *D.viscosa* and *C.muscosa* respectively. Stem number was found to differ significantly for *P.incana, B.africana,* and *M.longifolia* (Table 5). The overall pattern indicates that plant size is relatively unaffected by either harvesting or land use practises.

Table 4: Comparisons between volumes of medicinal plants from commercial and communal areas, using a Mann Whitney U test. Both mean volume (bold figures) and standard deviations are reported. P-values indicate the following: NS: no significance; ***NS**: no significance using the Mann Whitney U test, but significant using an independent t-test (results reported separately in the text).

Species	Volume (commercial) (m^3)	Volume (Paulshoek) (m^3)	N (commercial)	N (Paulshoek)	Z	p-value
Ballota africana	**0.09800** ± 0.21083	**0.05165** ± 0.05301	45	30	-1.4059	NS
Chrysocoma microphylla	**0.01964** ± 0.01451	**0.01890** ± 0.01626	40	30	0.6943	NS
Crassula muscosa	**0.00878** ± 0.00826	**0.00476** ± 0.00544	30	30	1.9368	***NS**
Diospyros austro-africana	**1.95304** ± 1.57362	**2.30104** ± 1.57513	30	30	-1.1828	NS
Dodonaea viscosa	**4.10101** ± 3.74874	**2.41621** ± 2.29045	30	30	1.6559	***NS**
Mentha longifolia	**0.02472** ± 0.03810	**0.01838** ± 0.02458	60	60	0.0656	NS
Pteronia incana	**0.08006** ± 0.08122	**0.06008** ± 0.06823	30	30	1.3897	NS
Rhus burchellii	**4.32155** ± 4.81438	**2.86458** ± 3.09170	30	40	1.1037	NS
Salvia dentata	**0.72152** ± 0.21083	**0.47152** ± 0.42147	35	30	1.6580	NS
Salvia sp.	**0.22881** ± 0.20510	**0.15195** ± 0.13296	40	30	1.3589	NS
Sceletium emarcidum	**0.00037** ± 0.00050	**0.00021** ± 0.00015	60	10	0.2434	NS
Senecio cinerascens	**0.07518** ± 0.17762	**0.07865** ± 0.14975	30	30	-0.1331	NS

Table 5: Comparisons between stem number of medicinal plants from commercial and communal areas, using a Mann Whitney U test. Both mean stem number (bold figures) and standard deviations are reported. P-values indicate the following: NS: no significance; bold figures denote the degree of significance.

Species	No. stems (commercial)	No. stems (Paulshoek)	N (commercial)	N (Paulshoek)	Z	p-value
Ballota africana	7.27 ± 6.61	11.90 ±6.64	45	30	-3.3904	**0.0007**
Chrysocoma microphylla	4.28 ± 2.24	5.03 ± 2.12	40	30	-1.3589	NS
Diospyros austro-africana	7.93 ± 3.87	9.10 ± 4.76	30	30	-0.9389	NS
Dodonaea viscosa	4.73 ± 2.65	5.60 ± 3.34	30	30	-0.8723	NS
Mentha longifolia	7.97 ± 6.87	5.47 ± 5.72	60	60	2.6269	**0.0086**
Pteronia incana	7.13 ± 3.58	4.40 ± 2.95	30	30	2.9347	**0.0033**
Rhus burchellii	10.70 ± 7.40	9.20 ± 5.71	30	40	0.4925	NS
Salvia dentata	20.11 ±6.76	18.57 ±7.76	35	30	0.7435	NS
Salvia sp.	13.38 ±8.16	11.83 ±7.97	40	30	0.7773	NS

ital

Results of the more detailed examination of S.dentata, B.africana, M.longifolia and S.emarcidum are outlined below.

Figure 4 demonstrates the differences in abundance of the four species between commercial and communal areas. Both *S.dentata* and *M.longifolia* are on average less abundant in the communal areas, but this is not statistically substantiated (Figure 4). It would thus appear that neither of these species is affected by either harvesting or land-use practises. It should be noted however that M.longifolia ital demonstrated significantly fewer stems when measured in Paulshoek, and that respondents from the PRA noted some decline in its abundance over time. This species is not highly palatable (Table 1) and from personal observation it appears that livestock avoid grazing it where possible. This plant is intensively harvested (Table 2) and therefore collecting of Mentha for medicinal use is the most ital probable explanation for the significant reduction in stem number of individuals found in Paulshoek.

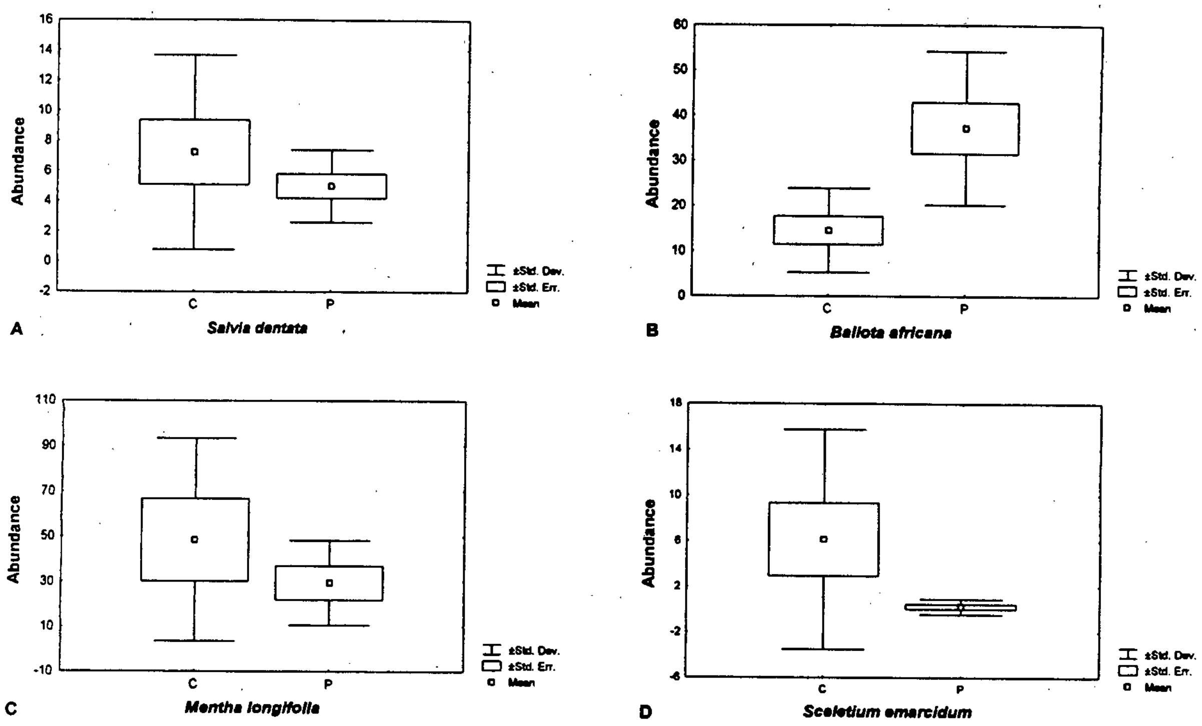

Figure 4 A-D : Comparisons of abundance of four species, between the commercial (C) and communal (P) areas. Significance levels using the Mann-Whitney U test for each species are as follows: ***Salvia*** (A):Not Significant: ($Z_{(35,\ 30)} = 0.7506$, $p>0.05$; ***Ballota*** (B): Significant ($Z_{(45,\ 30)} = -2.8698$, $p<0.005$); ***Mentha*** (C): Not significant ($Z_{(60,\ 60)} = 0.9677$, $p>0.05$); ***Sceletium*** (D): Significant ($Z_{(60,\ 10)} = 2.4283$, $p<0.05$).

In contrast to the results for *Salvia* and *Mentha, B.africana* and *S.emarcidum* show significant differences in abundance between commercial and communal areas (Figure 4), with *B.africana* being significantly more abundant in Paulshoek, and *S.emarcidum* more abundant in the commercial areas. Since dung-counts (a measure of stocking density) were found to be significantly higher in Paulshoek than in the commercial areas (Figure 5), these differences in abundance may be attributed at least partly to the greater impact of livestock on communal land.

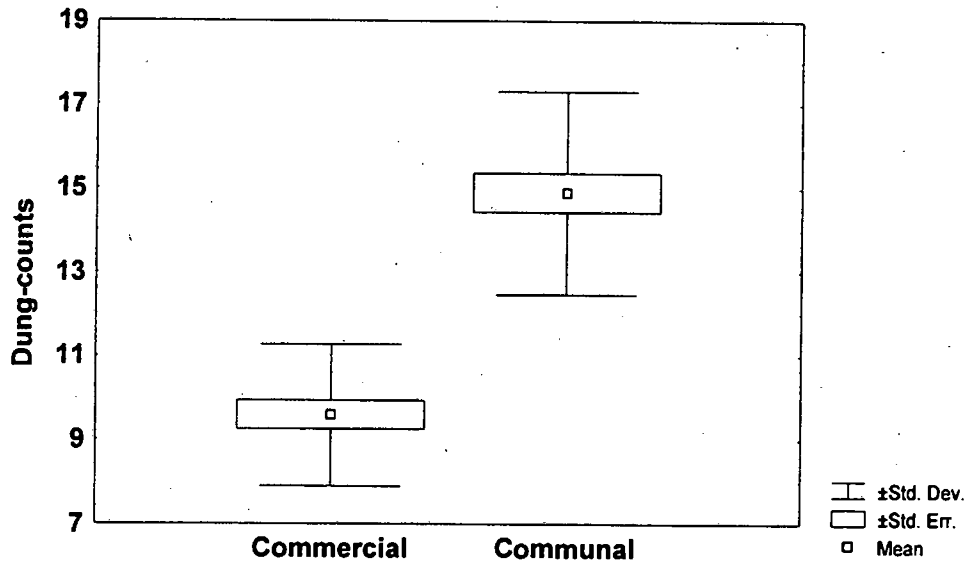

Figure 5: Differences in grazing intensity as measured by dung-counts between commercial and communal areas. Dung-counts were determined by evaluating the presence and age of dung in each transect (for greater details, see the text), and can have a value from zero to 30. Dung-counts correspond to stocking density. A t-test for independent samples demonstrated a significant difference ($t = -8.95$; $df = 49$; $p < 0.00001$).

Further analysis of the relationship between abundance and stocking density is displayed in Figure 6, where abundance of both species was correlated with dung counts. Abundance was highly positively correlated with grazing intensity for *Ballota* (Figure 6A), with similar regression slopes for both commercial and communal areas. The abundance of Sceletium was negatively correlated with dung counts (Figure 6B). However differences in grazing in communal and commercial areas do not seem to account directly for this plant's abundance patterns.

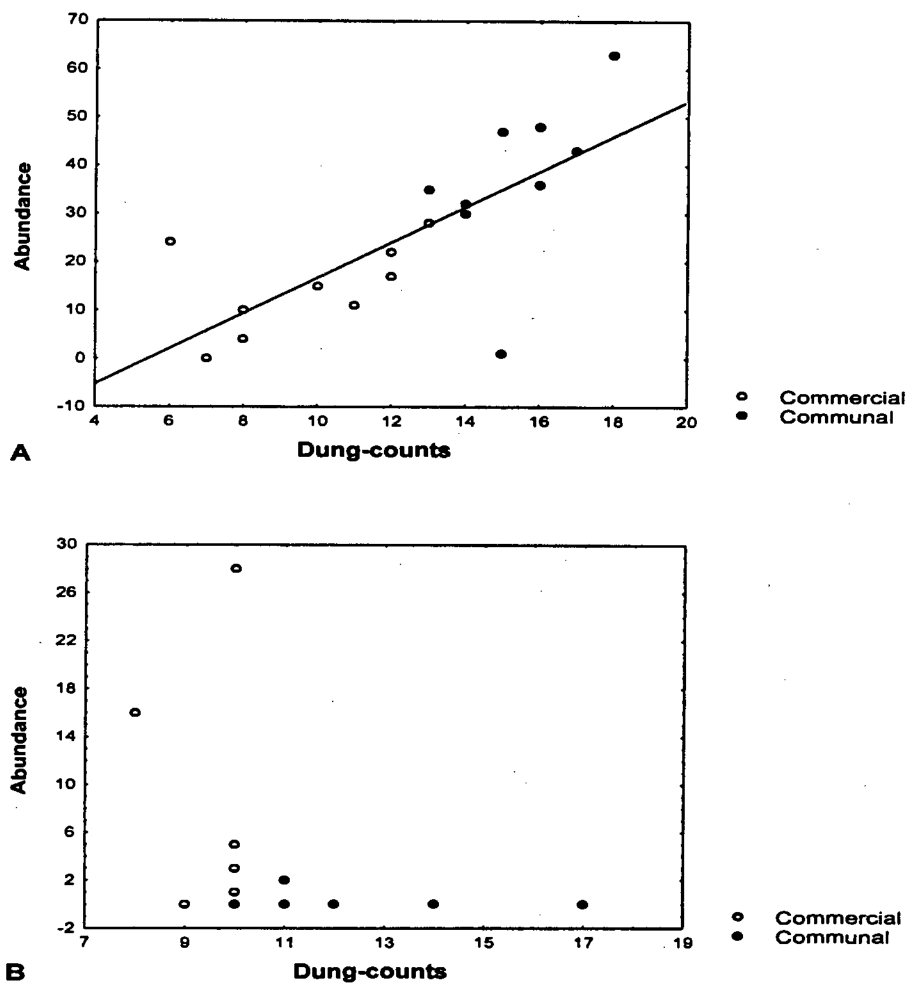

Figure 6: Relationship between grazing intensity and abundance of *Ballota Africana* (A) and *Sceletium emarcidum* (B) in Paulshoek. A t-test for independent sample means showed a significant correlation between abundance of *Ballota* and grazing intensity ($r=0.737$; $r^2=0.543$; $n=18$; $p<0.005$). A Spearman Rank correlation also showed a significant correlation for *Sceletium* ($R = -0.566$; $n=18$; $t(n-2)=-2.748$; $p <0.05$).

The positive correlation between *Ballota* and grazing intensity may be linked to a change in its preferred habitats. This species is seldom found in the open in either commercial or communal areas (Table 6) and shows a significant preference for growing under the canopy of other plants. Lower shrub cover in Paulshoek is therefore not the explanation for higher *Ballota* abundance.

Table 6: Observed versus expected frequencies of *Ballota* found in different habitats in commercial and communal areas. Chi-square test for each area are as follows: **Commercial:** χ^2 = 529.06, df = 1, p < 0.0000001; **Communal:** χ^2 = 2.68.03, df = 1, p < 0.0000001.

	Habitat	Observed	Expected	(Obs-Exp)**2/Exp
Commercial	Open	4	136.31	128.42
	Under plants	176	43.69	400.64
Communal	Open	7	157.94	144.25
	Under plants	335	184.06	123.78

Figure 7 clearly demonstrates that *Ballota* is found under certain species significantly more frequently than expected, in both communal and commercial areas. *Lycium, Diospyros* and *Rhus* seem to be the preferred "nurse" species. *Ballota* abundance is significantly correlated to the combined cover of these three species (Figure 8), which, in turn is significantly positively correlated to grazing intensity (Figure 9). Changes in cover of preferred nurse species may therefore contribute to patterns in *Ballota* abundance. However, the correlation between *Ballota* abundance and dung-counts, is much stronger than its correlation with cover, suggesting that grazing may also benefit the plant by means of competitive release. This may be substantiated by the significantly higher stem number for individuals found in the communal sites.

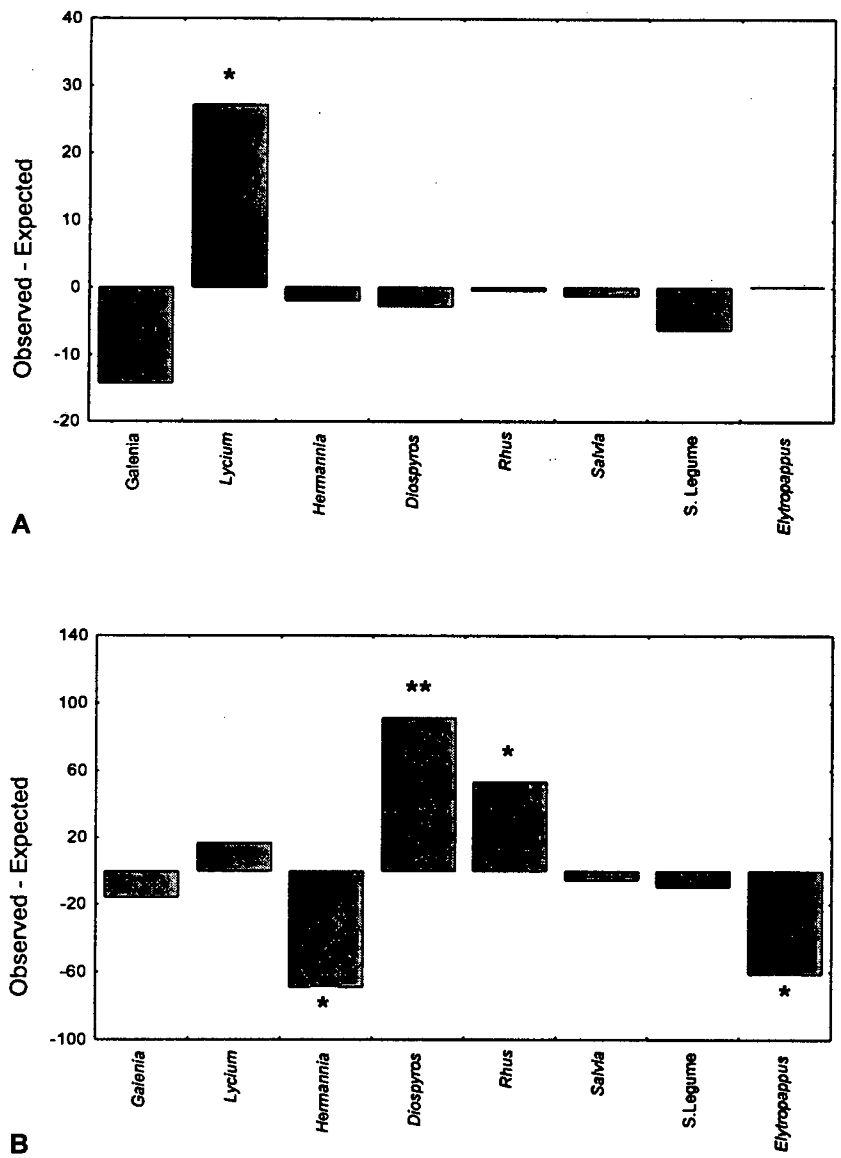

Figure 7: Preferential nurse-plant selection of *Ballota africana*. The figure shows the degree to which the abundance of *Ballota* deviates from expected, in both commercial (A) and communal (B) areas, assuming no nurse-plant preference. Values above zero indicate that the plant is found under the particular plant more often than expected, while a negative value indicates that the plant is found less frequently than expected. Chi square results for each area, are as follows: **Commercial** (A): $\chi^2 = 49.278$, df = 7, p<<0.0001; **Communal** (B): $\chi^2 = 361.604$, df = 7, p<<0.0001. Columns marked with an a single asterisk indicate figures which exceed the critical χ^2 value at 5% significance (p <0.05). The column marked with two asterisks (B) indicates the species that contributes most to χ^2.

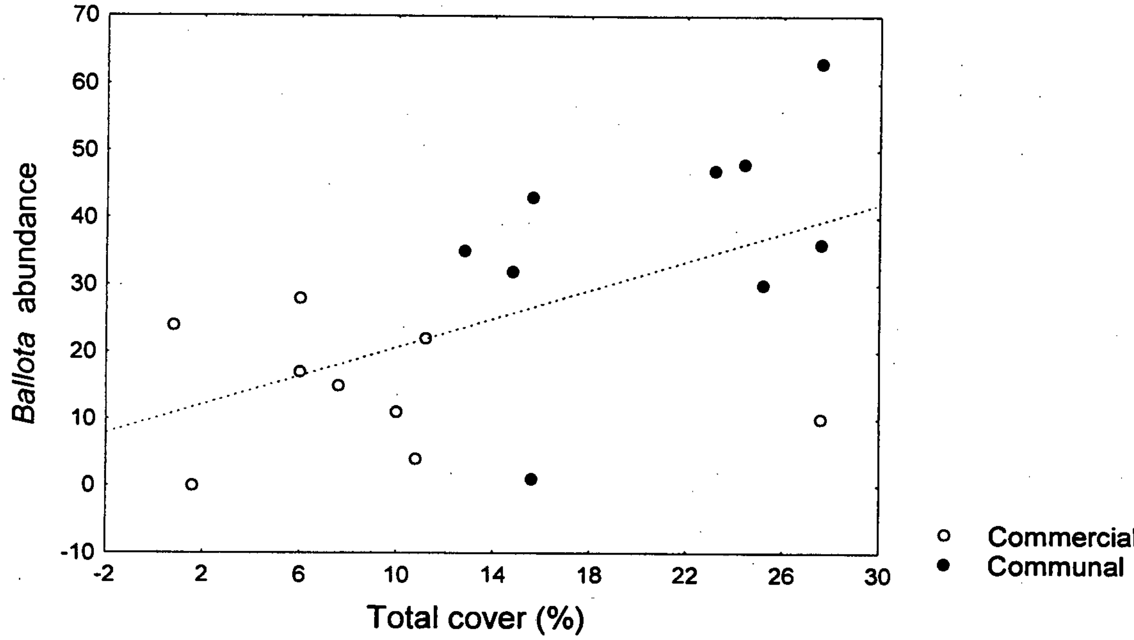

Figure 8: Relationship between *Ballota* abundance and combined percentage cover of *Lycium, Diospyros* and *Rhus*, showing a significant correlation (r=0.547; r^2=0.299; n=18; p<0.05).

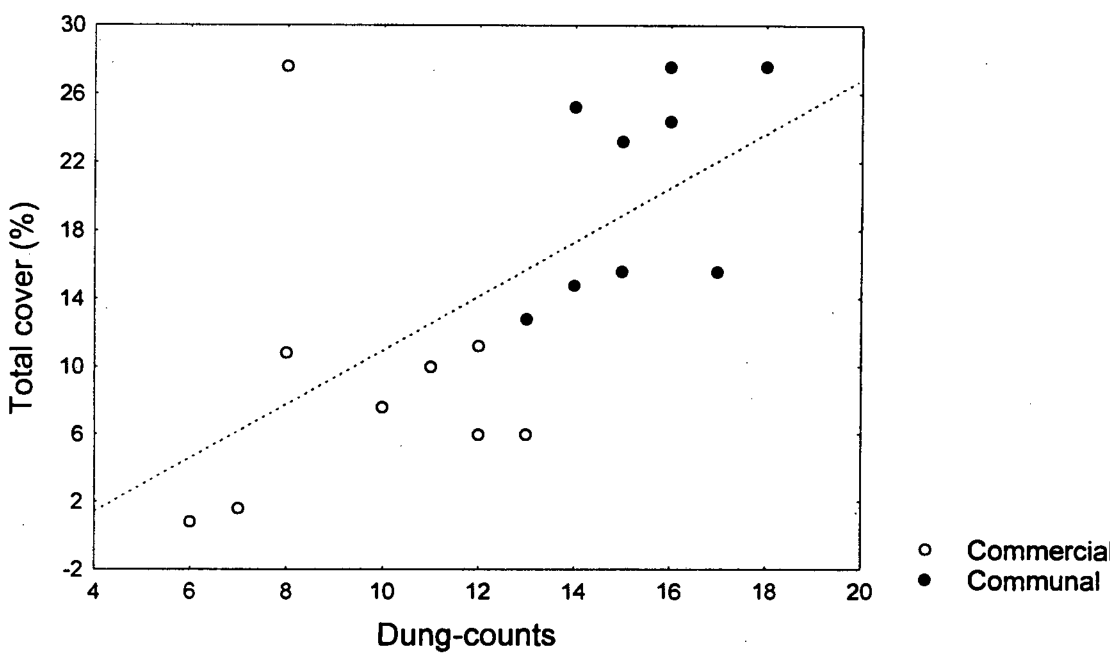

Figure 9: Relationship between combined percentage cover of *Lycium, Diospyros* and *Rhus*, and grazing intensity, showing a significant correlation (r=0.623; r^2=0.388; n=18; p<0.01).

While it is never observed in the open, *Sceletium* does not seem to have a particular preference for specific "nurse" plants. Only one (*Drosanthamum*) out of six species found in the commercial areas contributes significantly to the Chi-Square value (Table 6). As only 25% of all observed plants were found under *Drosanthamum* in the commercial area, one can assume that *Sceletium* does not rely on particular species for its survival. Thus while *Sceletium* was only found under the canopy of other plants, indicating that nurse plants are necessary for its survival, its abundance was not correlated to total shrub cover. (Spearman R = 0.2384; n=9, p=0.537). This suggests that that this species is either seed limited, or has a low dispersal ability, rather than restricted in abundance by the absence of suitable sites. *Sceletium* is probably a fairly scarce plant even in undisturbed habitats, which seems to be confirmed by its median abundance of one for all transects on the commercial farms.

Table 7: Observed versus expected frequencies of *Sceletium* found under different shrubs in the commercial area. Chi-square results are as follows: $\chi^2 = 22.15$, df = 5, $p < 0.0005$. Figures in bold indicate values which exceed the critical χ^2 value at 5% significance ($p < 0.05$).

Nurse species	Observed	Expected	(Obs-Exp)**2/Exp
Ruschia robusta	24	25.16	0.05
Herpisium	5	5.22	0.01
Euphorbia	3	9.17	4.15
Pteronia	3	1.35	2.03
Eriocephalus	10	13.38	0.85
Drosanthamum	15	5.72	**15.04**

These attributes make this plant highly vulnerable to any harvesting or grazing pressure. The drastic decline in abundance noted by all participants of the PRA is further evidence for this species' vulnerability. While this species is highly palatable most respondents attributed the present scarcity of this plant to intensive harvesting particularly over the last 10 years.

DISCUSSION

1 The state of local knowledge

From the interviews conducted it is apparent that there is a substantial division in knowledge within the community. While most people can name and identify at least a few medicinal plants, it seems that the more specialised knowledge is under threat. From the interviews it was clear that the herbalists are generally thought to be the most knowledgeable about medicinal plants, but that the present "bossiesdoktors" are less knowledgeable than their predecessors. Furthermore all three official herbalists are older than 50, and neither of the two that I interviewed have any one in mind to whom they could pass down their knowledge. However, these herbalists mainly use plants from other regions in the Kamiesberg and their knowledge of medicinal plants found in Paulshoek do not seem to differ substantially from the other respondents. Thus the loss of herbalist knowledge will probably not affect the knowledge state of the medicinal plant resource within Paulshoek.

A large proportion of the Paulshoek community use and collect medicinal plants and local knowledge of the medicinal plants found in Paulshoek is thus fairly widespread. It would therefore seem that the present knowledge is not immediately under threat. There are some residents feel that the knowledge is dying out, with relatively few younger people taking an interest in the subject. This concern is substantiated by the fact that very few of the people who collect medicinal plants are under the age of 40. However Paulshoek is a fairly poor community. Since conventional medicines are usually fairly expensive and the herbal remedies are reputed to be highly effective, I see little reason why the community would stop using medicinal plants to treat their common ailments. Further, since children under the age of 16 were found to constitute more than half the population that uses medicinal plants, it is probable that the tradition of medicinal plant use will be passed down to at least a few of the younger generation.

Thus while it appears that the present knowledge regarding the Paulshoek medicinal-plant resource is "sustainable", I feel that most of the knowledge regarding this resource has already been lost. In vegetation rich in geophytes it is somewhat surprising that this growth form is not at all utilised for medicinal purposes. Bulbs are important ingredients of herbal medicine in most parts of southern Africa (Cunningham 1990). Furthermore only 22 medicinal species were identified by all the Paulshoek residents in total which, seems a fairly low number in light of the high biodiversity of the region (Todd and Hoffman 1998). This is a markedly different pattern of utilisation when compared to medicinal plant use in other regions of South Africa. For example, in Kwazulu-Natal more than 400 medicinal plant species are recognised and commonly used (Cunningham 1991). While it could be that the Paulshoek flora is depauperate in plants that have medicinal properties, I speculate that this pattern of medicinal plant use rather reflects a substantial loss of knowledge.

2 The conservation status of the resource

This study has clearly shown that overall the medicinal plant resource in Paulshoek seems highly resilient to harvesting pressures and land use practises. This is evidenced by the fact that the abundance of most of the component species has not noticeably changed over time (Table 3), and that plant size for most species does not differ substantially between Paulshoek and the surrounding commercial farms (Table 4). This is not particularly surprising given that most of the plants are either woody shrubs or perennial herbs capable of vegetative reproduction (Table 1). These findings imply not only that the resource as a whole is sustainable in the landscape, but that harvesting for medicinal purposes has a relatively trivial effect. This study therefore demonstrates that biological resources can be sustainably *used.*

Although the ecological state of the resource in Paulshoek as a whole is not threatened in any significant way, the ecological status of some medicinal species is certainly of conservation concern. In particular, *Sceletium emarcidum* is highly threatened and although it is found throughout the Karroid areas of the north, west and east Cape Province (Gerbaulet, 1996), in Paulshoek it is on the verge of local extinction. Other species identified as being of potential conservation concern are *Rhus burchelli*, which seems to be adversely affected by harvesting and has demonstrated a marked decline in abundance, and *Mentha longifolia* which has shown signs of reduced fitness as a result of harvesting. In contrast, both *Galenia* and *Ballota* appear to have benefited from higher grazing pressures in Paulshoek.

While these findings suggest that neither harvesting nor land use practises have had substantial effects on the resource the limitations of biological studies such as this one should be realised. Ecological investigations can evaluate the *present state* of a resource effectively, but past or future *trends* are much harder to identify. This is especially true of studies which are only conducted over a very short time period, since the results represent a "snap-shot" of a landscape and ecosystem that is constantly changing. Due to the time constraints and nature of the project I was unable to assess the extent to which species may already have faced local extinction due to the aforementioned pressures. However Paulshoek shows evidence of high intensity grazing and this region has a long history of medicinal plant use. It is therefore reasonable to speculate that the relatively poor representation of more vulnerable life-forms in the medicinal resource of Paulshoek, may at least partly be due land use practices and harvesting which previously rendered many vulnerable species locally extinct. This suggestion appears to be substantiated by the fact that the few medicinal species which demonstrated a reduction in fitness tend to have less resilient life forms and were generally relatively rare in the landscape. Thus the plants representing the "highly sustainable" medicinal resource may simply be the most robust species of a resource which was once far for diverse.

3 Conservation implications

The results have clearly shown that both medicinal plant knowledge and the medicinal plants themselves have been and are being lost. Medicinal plants are undoubtedly important to the people of Paulshoek. However, while this implies a strong incentive for conserving this resource, the residents seem to be fairly passive in this regard. Although it is true that most medicinal plants are not in need of conservation management, the residents are clearly aware that certain species such as *Sceletium* are presently highly threatened in Paulshoek. In these cases, the impetus or the know-how for developing a conservation strategy is distinctly lacking. It would have been of great value to determine the extent to which the community believes they can actively help conserve the resource, and to explore how they might go about achieving this. It may be that the residents have not considered active conservation of their resources, in which case posing such a question would at least have created an increased awareness in this regard.

Having speculated that most of the vulnerable species have already gone extinct, it may seem futile or unnecessary to initiate a conservation effort or awareness programme at this point. However in light of land distribution claims, using results obtained during this study to develop a conservation strategy and to increase public awareness may prevent further degradation of the resource in Namaqualand.

This study has further demonstrated that identification of areas of potential conservation concern can only be achieved by investigating all components of a given resource. Thus determining the state of the resource as a whole is meaningless in terms of implementing an effective conservation strategy. This is clearly evidenced by the varying responses of the medicinal plant species to harvesting and land use practises. Furthermore successful conservation is contingent on a full understanding of all possible threats to a system. I therefore reiterate that to manage a biological resource sustainably, more than simply the impact of direct utilization must be assessed. This investigation has shown that various factors such as grazing pressure can have differing and sometimes unexpected impacts on component species of a single biological resource. Thus where possible all potential factors which could threaten the system need to be considered.

CONCLUSION

In general the state of the medicinal plant resource appears markedly different from the situation elsewhere in the country where plants are being severely affected by intense harvesting pressure. High population densities and a large demand for medicinal plants both for personal use and for commercial sale have placed significant pressure on this resource in most parts of the country, and sustainable harvesting rates are urgently sought. In contrast, the Paulshoek district is a fairly sparsely populated area and the plants of the region seem to have relatively low economical value. Furthermore most of the species are resilient to harvesting both due to their growth forms and because the harvesting practises do not cause severe damage to most of the plants. Contrast this with plant harvesting in most of southern Africa where whole plants, bark, roots and bulbs form the main ingredients of medicinal plants (Cunningham 1990). Thus while some species of the region have clearly been adversely affected by harvesting, the resource as a whole is not threatened by over-utilisation.

While this study is not representative of the state of the medicinal plant resource in South Africa as a whole, it serves as a novel protocol for assessing the sustainability of a resource which is extensively utilized. By combining social and ecological methodologies, such surveys are not only able to determine the present state of the biological resource but to evaluate trends over time. Invaluable insights can be gained by exploring local knowledge and an understanding of social perceptions and attitudes is imperative for assessing both the needs of the community that relies on a particular resource and also for identifying the steps necessary for successful conservation of the resource. Although interdisciplinary studies are often fraught with difficulties, integration of biological and social disciplines is necessary for identifying both human needs and for developing a framework for conservation in light of sustainable resource utilization.

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APPENDIX 1:

Questions asked during the brief interviews

1. How many people live in your house? How many of those are children?
2. How many people in your household use medicinal plants?
3. How many people in your household have consulted on of the official herbalists?
4. Who do you think is the most knowledgeable regarding medicinal plants?
5. How many people in your household collect plants for medicinal use?
6. For each person who collects medicinal plants, how old are they

APPENDIX 2:

Questions asked during the detailed interviews with respondents that personally collect medicinal plants.

1. Name a maximum of five plants that you frequently collect.
   1.1. For each plant, why do you collect it frequently?
2. Name a maximum of five plants that you collect only occasionally?
   2.1. For each plant, why do you collect it rarely?
3. For each species mentioned, :
   3.1. What plant parts do you harvest?
   3.2. Do you harvest from plants of a particular size?
   3.3. How far do you have to go to collect it? Has this changed over the last 10-15 years?
4. Are there certain plants that are only allowed to be harvested by particular people in Paulshoek?
5. Are their any places in Paulshoek where from no one may collect plants?
   5.1. If so, why?
6. Are there any traditions or local "laws" that you know of, regarding harvesting?
7. Do you think that the younger generation knows as much about medicinal plants as the older generation?

The following questions were directed only at the herbalists interviewed.

8. How many people do you treat every month?
9. Has this changed during the last 10 – 15 years?
10. Do you have other herbalists that ever come and buy medicinal plants

APPENDIX 3:

Questions asked and tasks performed during the PRA

1. Please identify and name each of the plant specimens. (Samples of each medicinal plant were presented in order to verify that I had identified the correct plants.)

2. Demonstrate, using the samples provided, how much of each plant is used for a single medical treatment.

3. How palatable are each of these plants?

4. Rank how the abundance of each plant has changed over time.